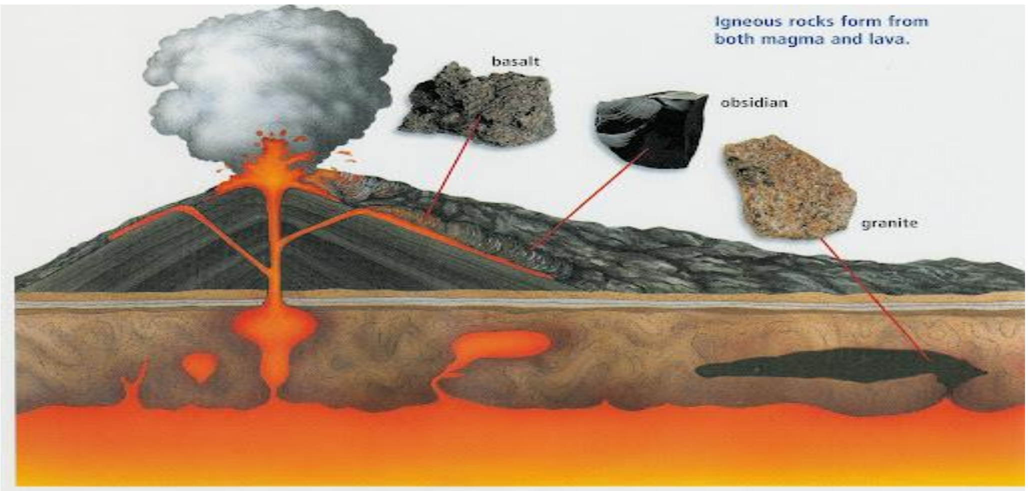
Democratic and People's Republic of Algeria

Ministry of Higher Education and Scientific Research

Adlehafid boussouf university center of MILA
Faculty Natural and life sciences
Department: Science of the Earth and the Universe

Petrology of igneous rocks 2nd year LMD Applied geology



• Learning Objectives:

The aim is to master the different minerals and the classification of igneous rocks, as well as the phenomena that cause their formation.

Recommended Prior Knowledge:

Master the petrography section of the L1 geology module.

BOUFEDAH BADISSI Mohamed Salah 2024-2025

Semester 4:

Unit: UEF 2.2.1

Subject: Petrology of Igneous Rocks

Coeff. 3 Credit. 5

Course: 09:30- 11:00 Class room No-09 / PW: 12:30 – 14:00 Class room No-03 .

Teaching objectives

This involves mastering the different minerals and the classification of igneous rocks, as well as the phenomena at the origin of their formation.

Recommended prior knowledge

Master the petrography part of the L1 geology module.

Content of the material:

COURSE

1- Introduction, reminders of L1

2- Methods for studying igneous rocks

3- The minerals of igneous rocks and their order of appearance

4- Origin of igneous rocks and their mode of deposits

5- Crystallization and evolution of magmas

6- Classification of igneous rocks

- Mineralogical classification
- Chemical classification

7- Large groups of igneous rocks

- Plutonic rocks
- Intermediate rocks
- Volcanic rocks

8- Alterations of minerals in igneous rocks

Practical work (12 sessions)

1st part

-Presentation of the microscope

-Notions of crystallographic indices

-Study in natural and polarized light

-Study in polarized light-analyzed

2nd part: minerals

-The cardinal minerals: Quartz; feldspars; feldspathoids

-Essential minerals: peridots; pyroxenes; amphiboles; micas; chlorites.

-Accessory minerals: zircon, apatite, sphene, garnets; epidotes; tourmaline; spinels; calcite.

-Textures of igneous rocks

-Nomenclature of igneous rocks based on their mineralogy.

Evaluation method:

Continuous review and monitoring.

Chapter I

Summary: Magmatism is a set of phenomena linked to the internal activity of the terrestrial globe. The cause of the eruptions is closely linked to the dislocation of the plates and the presence of gas and water vapor compressed under enormous pressures in the magmas. We often call igneous rocks, igneous rocks or eruptive rocks. The first term refers to fire, the second implies an exit outside, to the surface. The most common igneous rocks are granite and basalt: the granite "family" represents 95% of plutonic rocks and basalts represent 90% of volcanic rocks. The magmas at the origin of these different rocks can come from the Earth's mantle, the crust or even from an already existing remelted rock.

CHAPTER: I

INTRODUCTION TO PETROGRAPHY AND REMINDER OF L1

I. Introduction

Petrography is the art of rock description. Its purpose is to convey to another geologist an accurate and precise picture of the rock in question in whatever detail is demanded by the appropriate context. The petrography of igneous rocks is largely concerned with the observable features of mineralogy (a function of chemistry) and texture (a function of cooling history). It leads naturally to classification along these lines. Increasing use is being made of chemical data in igneous petrology for purposes of both classification and petrogenetic interpretation, but reliance on chemistry alone as a parameter, a temptation easy to succumb to, does not reveal the whole story, and in fact can be misleading. For example, chemical analysis of porphyritic volcanic rocks, particularly where the amounts of phenocryst species are not quoted, may reflect the influence of complex accumulative processes affecting the liquid line of descent. Analyses of cumulate rocks will reflect fortuitous variations in the proportions of cumulus minerals (of which the precise composition is the sole important index of fractionation) plus unknown proportions of intercumulus crystallization of varying type. Analyses of degraded igneous rocks may reflect the operation of metasomatic processes. In these instances and many others pétrographie detail can supply essential information. For communication in the field and at a more pragmatic level than that of advanced research, for example company and survey reports, petrography is the essential tool. To master petrography, therefore, is a sine qua non for anyone dealing with igneous rocks at whatever level. This is best accomplished by guided study, using one or more petrographical texts* with reference to a good collection of igneous rocks and accompanying thin sections. It is unfortunately commonplace to see geologists of all levels fail to make their meaning clear or even make unnecessary mistakes for lack of pétrographie experience and expertise.

II. Definitions:

Petrography: (from the Greek petra = stone, and graphein = to write) is one of the Earth Sciences which is concerned with the description and classification of rocks.

Petrogenesis: seeks to understand the mechanisms of rock formation.

Petrography + petrogenesis = Petrology.

Petrology: (from the Greek logos = speech, word) is therefore the science which is interested in the description, classification and interpretation of the genesis of rocks.

A rock: is a natural aggregate of minerals, mineraloids, glass and/or organic matter that makes up the earth's crust.

A mineral: is a solid (it is not a liquid or a gas), natural (it forms without human intervention), having a defined chemical composition (expressed by its chemical formula) and a structure ordered atomic (crystal).

Igneous ROCKS

I. Introduction:

Magmatism is a set of phenomena linked to the internal activity of the terrestrial globe. The cause of the eruptions is closely linked to the dislocation of the plates and the presence of gas and water vapor compressed under enormous pressures in the magmas. We often call igneous rocks, igneous rocks or eruptive rocks. The first term refers to fire, the second implies an exit outside, to the surface. The most common igneous rocks are granite and basalt: the granite “family” represents 95% of plutonic rocks and basalts represent 90% of volcanic rocks. The magmas at the origin of these different rocks can come from the earth's mantle, the crust or even an already existing rock

II. Definition of igneous rocks:

Magmatic rocks result from the solidification (crystallization, cooling) of magma. As magma is generally at a relatively high temperature (650 to 1250°C), these rocks are also called igneous rocks (or fire rock).

Magma is a molten silicate bath, consisting of a liquid phase, a solid phase (crystals) and a gas phase.

The solidification of magma can take place inside the lithosphere where cooling is slow, and the rocks formed are then called plutonic rocks. They therefore do not appear at the

surface than through the play of deformations of the earth's crust and erosion.

Magma can also undergo rapid cooling if it is emitted on the Earth's surface, in the open air or underwater: the rocks thus formed are called volcanic rocks (also called extrusive or effusive).

Between the two extremes, there are intermediates, and the rocks formed are named according to the context, semi-depth rock, *periplutonic* rocks, *hypovolcanic* rocks.

III. Caractères généraux des magmas:

III.1. Types of magma: Types of magmas are determined by their compositions

chemicals, and more especially by their silica content. Thus, we distinguish three main types of magmas:

- **Basaltic or gabbroic magmas** (basic): 45-52% SiO_2, rich in Fe, Mg, Ca, poor in K, Na.
- **Andesitic or dioritic magmas** (intermediates): 52 -65% SiO_2, intermediate in Fe, Mg, Ca, K, Na.
- **Rhyolitic or granitic magmas** (acids): 65-75% SiO_2, poor in Fe, Mg, Ca, rich in K, Na.

About 80% of magmas emitted by volcanoes are basaltic, and andesitic and rhyolitic magmas represent ~10% each of the total.

III.2. Gas: Most magmas contain gases (0.2 to 4% by weight) dissolved in the

liquid. Although they are present in small quantities, the gases have an enormous effect on the physical properties of the magma (the presence of the gases gives the magma its explosive character). The composition of gases in magmas is as follows:

Mainly H_2O (water vapor) with a little CO_2 (carbon dioxide) Together, they account for more than 98% of all gases emitted by volcanoes.

Other gases include N, Cl, S and Ar are rarely present at more than 1%.

The presence of gases in magmas is linked to their chemical compositions. Thus, rhyolitic magmas have a higher dissolved gas content than basaltic magmas.

III.3. Magma temperature: The temperature of a magma is difficult to measure because active volcanoes are obviously dangerous places. Geologists therefore use optical devices to measure the temperature of magma far from an eruption or they carry out laboratory experiments to determine the temperatures of molten rocks.

- Basaltic magma: 1000 – 1200°C.
- Andesitic magma: 800-1000°C.
- Rhyolitic magma: 650-800°C.

III.4. Viscosity of magmas: Viscosity is the resistance of magma to flow

(the more viscous a magma is, the less it behaves like a fluid). The viscosity of magma depends on its composition (silica content and dissolved gas content) and temperature.

Magmas rich in SiO_2 (silica) have a higher viscosity than those poor in SiO_2 (viscosity increases with increasing SiO_2 content of the magma). Low temperature magmas have a higher viscosity than high temperature magmas.

temperature (the viscosity of a magma decreases rapidly as the temperature increases). Thus, basaltic magmas tend to be very fluid (low viscosity), but their viscosity is still 10,000 to 100,000 times higher than that of water. Rhyolitic magmas tend to have a very high viscosity, which is on the order of 1 million to 100 million higher than that of water. Viscosity is a very important property which determines the eruptive character of magmas.

Summary

Summary Table

Magma Type	Solidified Volcanic Rock	Solidified Plutonic Rock	Chemical Composition	Temperature	Viscosity	Gas Content
Basaltic	Basalt	Gabbro	45-55 SiO2 %, high in Fe, Mg, Ca, low in K, Na	1000 - 1200 °C	Low	Low
Andesitic	Andesite	Diorite	55-65 SiO2 %, intermediate in Fe, Mg, Ca, Na, K	800 - 1000 °C	Intermed iate	Intermed iate
Rhyolitic	Rhyolite	Granite	65-75 SiO2 %, low in Fe, Mg, Ca, high in K, Na	650 - 800 °C	High	High